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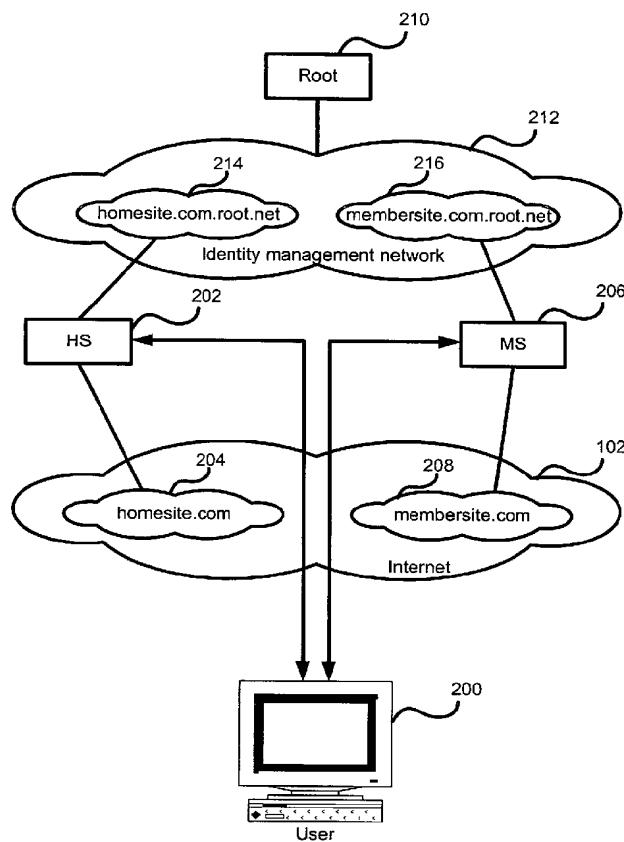
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(54) Title: DISTRIBUTED HIERARCHICAL IDENTITY MANAGEMENT



(57) **Abstract:** A system and methods for identity management and authentication are provided herein. The present invention employs shadow domains to prove entity membership in an identity management system where responsibility for trust relationships is devolved to the user. The present invention additionally teaches doubly signed certificate transmission for authentication of assertions made by third parties in the identity management network.

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**DISTRIBUTED HIERARCHICAL IDENTITY MANAGEMENT****FIELD OF THE INVENTION**

5 The present invention relates generally to a method and system for identity management. More particularly, the present invention relates to a distributed hierarchical identity management system and method if its use in distributed computer networks.

**BACKGROUND OF THE INVENTION**

In the field of electronic commerce there is an acknowledged need for a system and method to either manage or authenticate identity based information. It is 10 acknowledged among those skilled in the art that the authentication of identity based information is not related to guaranteeing that a user is who he or she says. Instead, authentication of identity is restricted to authenticating that a user has presented the same credentials that were previously presented when an identity was asserted. A simple way to understand this subtle difference is to examine a situation where a user is identified by a 15 user identification (user ID) to which there is an associated password. An electronic system has no way of determining who the user is when an account is initialized. However, after the account is initialized the presentation of the user ID and password in combination can be taken as proof that this is the same person who had previously registered for a service and provided these credentials. The presentation of a user ID and 20 password does not prove that the user is a particular individual.

Identity management is of great concern in the electronic commerce field because it allows an electronic vendor or service provider to provide a user with customized services and further allows the vendor to track user behaviour. From the user perspective, identity management permits a user to retrieve previously stored identifying information. 25 In the absence of any identity management system each individual use of a service would be accompanied by selecting a series of settings that could not be maintained in the following session. For example, in the case of an on-line purchase the lack of an identity management system would entail requiring a user to provide all identifying information, including credit card numbers, billing and shipping addresses for each and every purchase.

This is commonly regarded as a nuisance to consumers, and serves as a detriment to on-line commerce.

One skilled in the art will appreciate that though the following discussion generally relates to electronic commerce applications of identity management, a number of other 5 non commerce related services, such as customisation of a news site, registration for access to a newspaper, and maintenance of a desired display configuration for an electronic discussion site, all make use of identity management. For these services the ability of a user to have a single-sign on for multiple services is a high priority.

Figure 1 illustrates a first generation identity management system. A user **100** 10 connects over internet **102** to an electronic retailer **104**, commonly referred to as an E-tailer. E-tailer **104** is typically accessed using a hypertext transfer protocol (HTTP) session. Upon an initial visit to a site hosted by E-tailer **104**, user **100** creates a user profile including a user ID and password. The user ID and password, along with other associated 15 information, potentially including credit card information, shipping and billing addresses, and display preferences, are stored in user profile database **106**. Preferably, user profile database **106** is inaccessible to general computers connected to internet **102** to protect the confidential user information. After creating a user profile in user profile database **106**, user **100** can simplify further visits to E-tailer **104** by simply presenting a credential to 20 certify his or her identity. Typically, this credential is a combination of the user ID and password. Upon being presented with this credential, E-tailer **104** can perform a look-up in the user profile database **106** to confirm that user **100** has presented a valid identity credential. Upon successful completion of this check, user **100** will not be prompted to 25 provide already known information. From the perspective of E-tailer **104**, this system ensures that user **100** has provided all information required for transactions, which can then be stored in the user profile database **106**. This information can be correlated across a number of sessions or transactions to create user profile trends. From the perspective of a user, this system permits simplified dealings with E-tailer **104**. However, a drawback to this system is illustrated in Figure 2.

Figure 2 illustrates the network model of user **100** connecting, using internet **102**, 30 to two different E-tailers, E-tailer **104a** and E-tailer **104b**. Each E-tailer has its own user profile database: databases **106a** and **106b**, respectively. Because the user ID and

password is used to authenticate the identity of user **100**, E-tailers typically insists that each user ID be unique. Thus, it is conceivable that user **100** may have different user IDs at E-tailer **104a** and **104b**, in addition to further user IDs at other E-tailers not shown. Multiple user IDs are difficult to manage from the perspective of the user. Additionally, if 5 the user's information changes, for example if user **100** moves or changes credit card information, each user information database **106a** and **106b** must be independently updated. Though on a small scale this is merely troublesome, for many users who frequent 10 a variety of E-tailers this can be a great nuisance. Additionally, repeated entry of user data increases the probability that the user will inadvertently provide incorrect information, which is a detriment to the E-tailer. Thus in combination, the responsibility of ensuring the data integrity of a number of databases, and the hassles associated with multiple user IDs render this model of identity management lacking in the eyes of many users.

To ensure a unique user ID, many E-tailers use the e-mail address of user **100** in place of a user ID. However, the e-mail address provided by the user is not guaranteed to 15 be static over any length of time. In many cases, users are provided e-mail addresses by employers, internet service providers, or free e-mail providers. In all of these cases, it cannot be guaranteed that a user will not change an e-mail address due to a change in employment, a change in an internet service provider, or simple whim. As a result, users are required to resubscribe to E-tailers when their e-mail address changes.

20 To ensure that a user can use a single user ID for a plurality of services, and to provide what is commonly referred to in the art as "single sign-on", a second generation identity management and authentication solution was created. This solution is typically referred to as a hierarchical identity management system, and is typified by Microsoft's Passport<sup>TM</sup> service. An overview of this model is provided in Figure 3.

25 Figure 3 illustrates user **100** having a connection to identity provider **108** (IDP), preferably over internet **102**. User **100** provides IDP **108** with a set of identity based information which is associated with a unique user ID and password combination. This information is stored in user profile database **110**. When user **100** connects to an E-tailer 30 **112** which is affiliated with IDP **108**, user **100** provides E-tailer **112** with identity credentials that are transmitted to IDP **108** to authenticate user **100**. Typically, the credentials provided by user **100** to IDP **108** through E-tailer **112** are a user ID and

password combination. Upon authentication of user **100**, IDP **108** provides E-tailer **112** with the stored identity information. Typically, the information provided by IDP **108** to E-tailer **112** is either a strictly defined subset of the information stored by IDP **108**, or is the entire collection of data associated with user **100** stored by IDP **108** in user profile database **110**. Because IDP **108** stores information that can be accessed by a plurality of E-tailers with whom it is affiliated IDP **108** typically does not store site specific information, such as preferences a user has expressed on a particular site, nor does IDP **108** use user preference database **110** to store a history of any items purchased by user **100** at a given E-tailer. As a result, E-tailer **112** must maintain a separate user preference database **114**. The information in user preference database **114** is used to track the patterns of user **100**, and to maintain a purchase, or subscription history, for user **100**.

An exemplary transaction in this model entails user **100** requesting a web page from E-tailer **112** using an HTTP link over internet **102**. During this HTTP session user **100** indicates that he wishes to purchase a number of items. During a check-out type procedure E-tailer **112** asks user **100** to authenticate identity. In order to receive authentication from IDP **108**, E-tailer **112** requests and receives from user **100** the credentials required for authentication which are then passed to IDP **108** and authenticated. In an alternate embodiment, user **100** does not provide E-tailer **112** with authentication information. Instead, when E-tailer **112** requires authentication of identity, it redirects user **100** to IDP **108** and upon completion of this transfer user **100** provides the IDP **108** with the authentication information required. Upon successful authentication of user **100**, IDP **108** redirects user **100** back to E-tailer **112**. Using either the same, or a different, data communication channel, IDP **108** provides E-tailer **112** with the information stored in user profile database **110**. This information is then correlated with information stored in user preference database **114** to ensure that user **100** can access historical information.

This model of identity management addresses the single sign-on problems associated with the first model of identity management, however, a number of other issues are introduced. A first problem is the trustworthiness of the entity running IDP **108**. This entity must be trusted by both E-tailer **114** and user **100**. IDP **108** must be trusted by user **100** to safeguard information and to provide that information only to entities approved by

user **100**. E-tailer **112** must trust IDP **108** to provide reliable service, accurate data, and to not act in a predatory manner. If E-tailer **114** is a service provider that offers a service competing with a service offered by the entity running IDP **108**, E-tailer **114** will typically not have a high level trust in IDP **108**.

5 As a result of many privacy concerns among users, the Microsoft Passport<sup>TM</sup> service is implemented in such a manner that a user is never required to provide E-tailer **114** with identity authentication information. Instead re-direction commands are used to pass a user from E-tailer **114** to IDP **108** over a secure connection. Over this secure connection, user **100** provides IDP **108** with identity authentication information. Upon  
10 authenticating user **100**, IDP **108** redirects user **100** back to E-tailer **112** and provides E-tailer **112** with authentication and user information in a secure back channel. To ensure that two E-tailers cannot correlate the information about a single user **100** at different sites, IDP **108** provides E-tailer specific identity coding which prevents E-tailers from using the identity coding index to correlate a user between two sites. However, one skilled in the art  
15 will appreciate that E-tailer **114** typically has a credit card number associated with user **100**, and thus two E-tailers sufficiently motivated to share information could correlate their databases using credit card information, email addresses, or home addresses, as a cross-referencing field.

20 The present embodiment of Microsoft's Passport<sup>TM</sup> system has failed to gain sufficient traction in the electronic commerce marketplace to dislodge the first generation of identity management systems. One reason for this is that a centralized user profile database such as user profile database **110** typically has a static data schema. That is it has a pre-defined set of information that it stores. However, different E-tailers typically request different sets of information from a user. Because a centralized user profile  
25 database **110** is not designed to store all information that a variety of E-tailers require, many E-tailers have determined that it is not worth their while to transition to a centralized user profile database **110** such as that offered by Microsoft's Passport<sup>TM</sup> service. Another reason for the inability of the Passport<sup>TM</sup> service to displace first generation identity management systems is user wariness in providing a single entity with vast amounts of  
30 identity information. In order for a user to trust an IDP sufficiently to provide this amount of information, a pre-existing trust relationship, and a user assumption of the security of

the data must be present. As many users have not had a historical relationship with Microsoft of this type, many users are very reluctant to provide this information.

Another concern among many parties is that a hierarchical identity management system promotes monopolistic tendencies. To address these concerns a third generation 5 model of identity management system has been created by the Liberty Alliance. This model can best be described as a distributed identity management system. Such a system is illustrated in Figure 4.

Figure 4 illustrates the distributed identity management system proposed by the Liberty Alliance. This specification describes a plurality of identity providers, here 10 illustrated as IDP1 **116**, IDP2 **120** and IDP3 **124**, having user profile databases UPD1 **118** UPD2 **122** and UPD3 **126**, respectively. All IDPs exist in a web of trust **128** where each IDP has a trust relationship with every other IDP, trust relationships are shown in dash lines. To provide data security, communication between IDPs in web of trust **128** is done 15 using asymmetric encryption. Thus, in the example of Figure 4, IDP1 **116** has a public and private encryption key associated with it, as do IDP2 **120** and IDP3 **124**. IDP1 **116** also has the public keys of IDP2 **120** and IDP3 **124**. Thus, all requests directed between two IDPs can be encrypted using the public key of the destination IDP and can be signed using the private key of the transmitting IDP. Thus, if IDP1 **116** needs to communicate with IDP2 **120**, it encrypts the request to using the public key assigned to IDP2 **120** and signs 20 the encrypted message using its own private key. IDP2 **120** is able to de-crypt the encrypted message using its private key, and verify the signature of IDP1 **116** using the public key assigned to IDP1 **116** stored in IDP2 **120**. This ensures that each IDP in web of trust **128** is able to communicate with every other IDP in the web of trust without fear that the data channel between IDPs has been compromised. User **100** registers with one of the 25 IDPs in web of trust **128**, as shown in Figure 4, user **100** is associated with IDP3 **124**. IDP3 **124** stores identity information provided by user **100**, along with identity credentials in UPD3 **126**. When user **100** establishes a session with an E-tailer associated with any of the IDPs in web of trust **128**, such as E-tailer B **132**, user **100** can provide E-tailer B with identity credentials that will then be provided to one of the systems in web of trust **128**. As 30 illustrated in Figure 4, E-tailer B **132** is affiliated with IDP2 **120**. Thus, ID credentials of user **100** are presented to E-tailer B **132**, which relays them to IDP2 **120**. To authenticate

user credentials of user **100**, IDP2 **120** determines that user **100** is affiliated with IDP3 **124** and thus creates a secure data connection using public and private data keys between itself and IDP3 **124**. This data connection is used to authenticate the identity credentials provided by user **100**. Upon authenticating user **100**, IDP3 **124** provides IDP2 **120** with 5 identity information which is then relayed back to E-tailer B **132**.

This system provides the user **100** with a single sign-on capability and addresses the concerns related to monopolistic tendencies of an IDP. Because each IDP is independent of other IDPs, it is not considered a global storehouse of information. Thus, if an IDP security is breached only the information associated with that IDP's user profile 10 database is comprised. This is an advantage over the hierarchical model where comprise of the user profile database exposes all users in the system.

However, according to the specification of the Liberty Alliance, only a defined set of user identity information is stored at the IDPs. Thus, E-tailers must still question user **100** about information not stored by an IDP. Additionally, public and private encryption 15 keys require each IDP to be able to perform numerous computation intensive tasks for each data request. Additionally, a sophisticated key management system must be employed as the size of the web of trust increases. Though Figure 4 only shows three IDPs, the model proposed in the Liberty Alliance specification is not so limited. One skilled in the art will readily appreciate that the number of IDPs in a web of trust cannot 20 scale infinitely. Though it is possible to implement a system whereby each IDP can trust every other IDP when there is a small number of IDPs, it is unlikely that such a system can be implemented in a reliable fashion when the number of IDPs scales into the tens of thousands.

From the perspective of user **100**, the model presented by the Liberty Alliance has 25 a number of drawbacks. A user's single sign-on abilities are somewhat restricted. A user is assigned a unique user ID that identifies them to their selected IDP. When a user is authentication by an IDP in the web of trust, the E-tailer is provided a pair-wise unique identifier (PUID) that can be used in the future to identify the user. The PUIDs assigned to two E-tailers for the same user will be different to prevent cross-correlation of user 30 purchases or activities, as the PUID is pair-wise unique. Only the IDP associated with the user holds the PUIDs provided to E-tailers, thus, migration from one IDP to another is not

possible. If a user wishes to move from IDP3 124 to IDP2 120, an entirely new identity must be created, and all information stored in IDP3 124 must be re-entered by the user for storage in IDP2 120. This is viewed by many users as handcuffing them to an as yet untested system. As a result, there is great reluctance among many users to register for this 5 service. For E-tailers and potential IDPs, participation in the Liberty Alliance includes agreeing to certain business model restrictions, including how user information must be stored and how it can be used for either statistical or marketing purposes. These restrictions are considered to be limiting the number of parties wishing to participate in the Liberty Alliance.

10 Both Passport<sup>TM</sup> and the Liberty Alliance provide E-tailers and other sites requiring user authentication with PUIDs. Puids allow the e-tailer to store information and build a profile on a user, while preventing two e-tailers from easily correlating their databases to determine user activities and patterns. Puids in the liberty alliance are assigned by the IDP holding the user profile, and cannot be matched to the user account by 15 any other IDP, thus if a user chooses to change IDPs all the site specific settings at each E-tailer are lost. This handcuffs users to an IDP providing no more opportunity for portability for most users than the single source Passport<sup>TM</sup> does. Furthermore, the purpose of the PUID assigned by either Passport<sup>TM</sup> or the Liberty Alliance can be overcome as earlier discussed by correlating other information such as credit card information.

20 None of the present identity management systems are able to provide both a single sign-on service, specialty information required by many E-tailers, portability of identity information, and as a result none of the services has been able to supplant any of the others. It is, therefore, desirable to provide an identity management system that provides a dynamic user information set, scales and does not rely upon a global data store.

25 **SUMMARY OF THE INVENTION**

It is an object of the present invention to obviate or mitigate at least one disadvantage of previous identity management systems.

In a first aspect of the present invention, there is provided an identity management system for providing authentication of a user to a membersite. The identity management 30 system comprises a root server having a user database for storing a globally unique

identifier associated with the user. The root server has means for providing the globally unique identifier to the user, for maintaining a list of network addresses associated with names in a shadow domain for providing to a domain name server, each name associated with either the membersite or a homesite in an identity management network. The root 5 server permits the homesite to authenticate an entity accessing the membersite as the user associated with the globally unique identifier, when the user is redirected to the name associated with the homesite in the shadow domain. The root server may optionally include homesite authenticator for providing the membersite with authentication of the authority of a homesite to authenticate the entity as the user associated with the globally 10 unique identifier.

In an embodiment of the first aspect of the present invention, the identity management system includes a homesite, in communication with the root server and having a user profile database, a user authentication engine, and a domain name in the namespace of the shadow domain. The user profile database stores both the globally 15 unique identifier and authentication information associated with the user. The authentication engine allows the homesite to authenticate the identity of the user. The authentication information is optionally a combination of a user ID and password. In another embodiment, the user profile database further stores identity information associated with the user, and the authentication engine includes means to provide the 20 membersite with a subset of the identity information upon authentication of the user. In a further embodiment of the present invention, the authentication engine provides the authenticated user identity to the membersite by providing the user with a cookie containing authentication information readable by the membersite and redirecting the user to the membersite, the cookie is optionally signed by the homesite, and includes indication 25 from the root server that the homesite is authorized to authenticate the globally unique identifier. The indication is optionally an assertion signed by the root server. In another embodiment, the authentication engine provides the identity information associated with the user to the membersite through one of redirection of the user to an authentication encoded universal resource locator, and both providing the user with a cookie containing 30 authentication information readable by the membersite and redirecting the user to the membersite.

In a second aspect of the present invention, there is provided a method of providing user authentication to a membersite in a identity management network. The method includes obtaining the name of a homesite, providing the homesite with an authentication request and obtaining the authentication of the user from the homesite. The step of 5 obtaining the homesite name includes obtaining from the user the name of a homesite that can provide user authentication based on user authentication information known to the homesite. The step of providing the homesite with an authentication request includes redirecting the user to the homesite in a shadow domain associated with the identity management network. The step of obtaining the authentication includes obtaining the 10 authentication of the user from the homesite in response to the homesite receiving the known authentication information from the user, the authentication including a globally unique identifier associated with the user. In an embodiment of the second aspect, the step of obtaining the name of the homesite from the user includes the membersite examining a cookie provided by the user. In another embodiment, step of providing the homesite with 15 an authentication request includes the user resolving a name associated with the homesite in the shadow domain to a network address. In a further embodiment the step of providing the homesite with an authentication request includes the membersite providing the user with a cookie, readable by the homesite, containing a request for authentication of the user. In yet another embodiment, the homesite can provide both user authentication 20 information and user identity information, and the step of providing the homesite with an authentication request additionally includes the membersite providing the homesite with an identity information request, while the step of obtaining the authentication additionally includes the obtaining identification information in response to the homesite receiving the known authentication information from the user. In a further embodiment, the method 25 includes the steps of obtaining identity information not provided by the homesite, and providing the obtained identity information to the homesite by redirecting the user to the homesite in the shadow domain, where the identity information not provided by the homesite is obtained from the user.

In a third aspect of the present invention, there is provided a method of performing 30 a user authentication at a homesite in an identity management network. The method comprises the steps of receiving from a user, having a globally unique identifier and

known authentication information, a request to provide authentication for a membersite; and providing authentication of the user to the membersite in response to receiving known authentication information by redirecting the user to the membersite in a shadow domain associated with the identity management network. In an embodiment of the third aspect, 5 step of the providing the membersite with authentication of the user includes receiving from the user a user ID and password combination associated with the globally unique identifier of the user. In another embodiment, the step of providing the membersite with authentication of the user includes the user resolving a name associated with the membersite in the shadow domain to a network address and further, the step of providing 10 authentication of the user optionally includes the homesite providing the user with a cookie, readable by the membersite, containing authentication of the user and the globally unique identifier associated with the user. In other embodiments, step of receiving a request to provide authentication information includes receiving an identity information request, the step of providing authentication includes the providing the membersite with 15 identification information upon receipt of the known authentication information from the user, and the step of providing the membersite with identification is preceded by obtaining user authorization for the transfer of the requested identification information to the membersite. In another embodiment, the method includes the steps of receiving from the user, identity information obtained by the membersite; and storing the transferred identity 20 information in a user profile database.

In another aspect of the present invention, there is provided a method of obtaining a globally unique identifier associated with user having an email address. The method comprises the steps of receiving a request from the user to associate a globally unique identifier with the email address; requesting, from a root server that associates globally 25 unique identifiers with email address, the assignment of a globally unique identifier associated with the user email address; and obtaining the globally unique identifier associated with the email address in response to the user providing the root with a response to a challenge transmitted to the email address.

Other aspects and features of the present invention will become apparent to those 30 ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Embodiments of the present invention will now be described, by way of example only, with reference to the attached Figures, wherein:

5 Fig. 1 is a block diagram of an identity management system of the prior art;

Fig. 2 is a block diagram of a identity management system of the prior art;

Fig. 3 is a block diagram of a hierarchical identity management system of the prior art;

Fig. 4 is a block diagram of a distributed identity management system of the prior art;

10 Fig. 5 is a block diagram of a distributed hierarchical identity management system of the present invention;

Fig. 6 is a flowchart illustrating a method of the present invention;

Fig. 7 is a flowchart illustrating a method of the present invention;

Fig. 8 is a flowchart illustrating a method of the present invention;

15 Fig. 9 is a flowchart illustrating a method of the present invention; and

Fig. 10 is a flowchart illustrating a method of the present invention;

**DETAILED DESCRIPTION**

Generally, the present invention provides a method and system for identity 20 management.

For an identity management system to be successful, users must trust the entity storing their personal information, and must be provided a set of features that encourage the use of the system. Without a sufficient user base the identity management system cannot attract service providers, and is thus unsuccessful.

25 From a user perspective the system must provide a simple registration process with a trusted entity. After registration, the user should be provided with a simple method of logging into services using a single login, and should be provided with a simplified mechanism for registering for those services. The user should be provided with a simple mechanism for providing the trusted entity with additional information. Finally,

interactions between a vendor/service provider and the trusted entity should be largely transparent to the user.

From the perspective of the vendor or service provider, traditional identity management systems have posed problems because of the degree of trust that is required between the vendor and the authentication authority. These trust issues are resolved in the present invention by devolving the trust responsibility to the user. If a user trusts an entity to hold his personal information and serve as an authentication authority, the vendor can be satisfied that the user is comfortable in the trust relationship, and thus the vendor can trust the authentication authority. This trust relationship is sufficient so long as the authentication authority remains in the identity management network.

From the perspective of the authentication authority, an agreement made with the user can be designed to serve the business needs of the authority, rather than being dictated by a central body as it is with the Liberty Alliance. Additionally, the authentication mechanism is left to the authentication authority and the user to agree to. Thus, different authentication authorities can employ different authentication mechanisms such as user ID and password combinations, smart cards, biometric samplings and other known user authentication techniques. If a user become disenchanted with either the authentication mechanism or the service provided by the authentication authority, the user can change the authentication authority used to store and authenticate the identity information.

To administer the network, a central authority is established. This central authority defines the schema used by the authentication authority for storing the user identity information, which allows the vendors in the identity management network to request information from predefined fields. The central authority also provides a mechanism to both vendors and authentication authorities to ensure that the other party in a communication is a part of the identity management network.

All computer systems connected to a public network such as the Internet have an assigned numeric network address. This address serves as a unique identifier and additionally provides routing information so that packets addressed to a network node can be effectively routed to the specified node. To simplify addressing issues for human interactions with the network, alphanumeric domain names are assigned to nodes and a

lookup facility is provided, typically through a domain name server (DNS), to allow the alphanumeric domain names to be translated into the numeric addresses. These techniques are well known to those skilled in the art. Another known use of the domain name system is to restrict access to systems within a domain. By only addressing transmissions using 5 the alphanumeric domain name, a transmitting system can restrict systems outside the domain specified in the alphanumeric domain name from receiving the packets. The relative security of the DNS system is trusted by almost the entire Internet to be free from malicious redirection on a global scale. Shadow domains, as referred to in this application, are domains created in the internet under the namespace of a central authority. All entities 10 in the identity management network can be assigned a name in the shadow domain that is resolved to a numeric address associated with the entity. Thus a vendor can have a shadow domain address that resolves to the same numeric address as their primary domain, or it can be resolvable to numeric address different than the primary domain, but associated to another system controlled by the vendor. Technique using shadow domains are preferably 15 used in the present invention to ensure that both a vendor and the authentication authority are in the identity management network.

The following discussion will outline the architecture of the identity management network, the roles played by each entity, and will illustrate how the architecture provides for user registration with the identity management network; a single sign on functionality; 20 simplified registration for services requiring user information stored by the authentication authority; a mechanism to update the schema used by the authentication authority to store user data; a mechanism for a vendor or service provider to back-fill user information to the authentication authority; a mechanism for the user to change authentication authorities while maintaining all sign ins and without providing information already stored; and a 25 method for the central authority to remove vendors and authentication authorities from the identity management network. Additionally, security features arising from the architecture and novel trust chains for the signing of certificates and keys will be presented along with other advantages of the architecture and methods of the present invention.

In the following discussion, the central authentication authority is referred to as the 30 root of the hierarchical distributed identity management network, or simply as the root. The authentication authority is referred to as a homesite (HS) as it provides a home for the

user's data. Any site requesting either user authentication or user identity information is referred to as a membersite (MS). The user is still referred to as the user.

Figure 5 illustrates an architecture used for the hierarchical distributed identity management system of the present invention. There are four entities in Figure 5, the user 5 **200**, the homesite (HS) **202**, the membersite (MS) **206**, and the root **210**. Each of the entities will be described in relation to the role that they play in the authentication and identity management method. As Figure 5 is merely exemplary, additional homesites and membersites are not illustrated, though they may be present.

User **200** is a user having a connection to a common public network such as 10 Internet **102**. User **200** has information associated with his or her identity, such as addresses, billing information, and other personal information such as calendar based information. User **200** selects homesite (HS) **202** to store this identity information and to provide identity authentication for single sign on services.

HS **202** includes a user profile database (not shown) that is used to store the 15 identity information for user **200**. HS also associates a global identifier (GUID) with the identity information of user **200**. The GUID is a globally unique identifier that is assigned to HS **202** by root **210**, in a method that will be described later. HS **202** has a unique network address, and a domain name **204** associated with the address, here illustrated as homesite.com. Thus to access HS **202**, user **200** can direct a web browser to 20 www.homesite.com, and through a Domain Name Server (DNS) the address will be resolved to the address of HS **202**.

Membersite **206** (MS) is a node on the public internet **102** having the domain **208** membersite.com associated with its network address. MS **206** provides a service to which user **200** subscribes, or sells a product that user **200** would like to purchase. To allow user 25 **200** to sign in, or to obtain personal information about user **200**, MS **206** requires either authentication of user **200** or a set of requested information related to user **200**.

User **200** provides identity information to homesite **202** (HS). Associated with the information provided by user **200** to HS **202** is a set of identification credentials. For the purposes of the following discussion, the user credentials will be referred to as a user ID 30 and password combination. However, one skilled in the art will readily appreciate that any number of other authentication methods, including biometric readings, static IP traces and

smart card derived information, can be used in place of the user ID and password combination.

HS **202** has primary domain **206** homesite.com associated with its IP address through the conventional domain name system. HS **202** can be accessed by user **100**, or 5 any other system on the network through both a numeric IP address, and through a domain name associated with that IP address. MS **206** can also be accessed using a unique numeric IP address, or a domain associated with its IP address. In addition to having primary domains in internet **102** (not shown) both HS **202** and MS **206** are connected to each other through a shadow domain administered by Root **210**. Root **210** administers a 10 shadow domain associated with identity management network **212**. Thus, while HS **202** can be accessed by user **200** at its primary domain **204** of homesite.com, and membersite **206** can be accessed by user **200** at its primary domain **208** of membersite.com, they can both be reached in a shadow domain at homesite.com.root.net and membersite.com.root.net respectively. One skilled in the art will appreciate that primary 15 and shadow domain name pairs will both resolve to the same entity, though not necessarily the same address. The shadow domain administered by root **210** is illustrated as identity management network **212**. In the model of Figure 5, identity management and authentication is provided by a distributed hierarchical identity management system. In this system, membersites rely upon any homesite in the same shadow domain to 20 authenticate a user. Whereas previous identity management systems encounter resistance from E-tailers or other service providers because of the amount of trust that must exist between an IDP and an E-tailer, the present model obviates that need. MS **206** relies upon HS **202** only to authenticate that the user **200** has provided the same credentials for authentication that previous users claiming to be user **200** provided. The integrity of HS 25 **202**, the ethics of its business practices, and how it treats the information of user **200** is no longer a concern of the membersite **206** and instead MS **206** relies upon user **200** to determine if HS **202** is trustworthy. If it is determined by a plurality of users that a given homesite in this model is untrustworthy, users will not use the homesite, and can petition for it to be removed from the network by root **210**. Thus, policing of the homesite is a duty 30 assigned to users, not vendors. Additionally, because the network is distributed there is no restriction placed insisting that a membersite cannot also be a homesite. As a result, fear

that an IDP will usurp business, and steal customers can be addressed by allowing any membersite to also act as a homesite. The only requirement placed on any membersite or homesite is that they remain part of the shadow domain.

To establish an identity profile with HS **202**, user **200** provides profile information 5 and credentials such as a user ID and password, and receives a token indicating that he can be authenticated by HS **202**. In the presently preferred embodiment, the token is a cookie that is referred to as a homesite cookie. This token is accessible to any entity in the shadow domain. When user **200** visits MS **206**, it will present the token only if it is redirected to the shadow domain. To accomplish this, MS **206** can provide a link 10 indicating that all users with identity information stored in identity management network **212** should click to either register or authenticate as the case may be. This link would then redirect the user to the shadow domain **208**, so that the homesite cookies can be retrieved. The user can then be provided a second cookie and directed to HS **202** in either the primary domain **204** or the shadow domain **214**. Alternately, upon visiting MS **206**, user 15 **200** can be redirected to shadow domain **216** and then back to the primary domain **208** so that the cookie is retrieved in advance of a login request. Upon request for authentication through the HS **202**, MS **206** can provide user **200** with the second cookie. The second cookie can be used to request authentication and to provide a challenge to HS **202** that must be signed. This can be used to ensure that HS **202** is in identity management network 20 212, and is authorised to authenticate user **200**. These redirections can be done in a manner that is transparent to user **200**. Because user **200** can only provide the cookie to requests to originating the shadow domain corresponding with identity management network **212**, confirmation that HS **202** and MS **206** are in the identity management network **212** is 25 obtained by virtue of the request being completed. A more complete description of how authentications and information transfers are performed is presented below.

Root **210** administers the shadow domain to allow verification that HS **202** and MS **206** are affiliated with identity management network **212** by creating shadow domains homesite.com.root.net **214** and membersite.com.root.net **216** for HS **202** and MS **206** respectively. Root **210** also performs a number of other functions including the assigning 30 globally unique identifiers (GUID) to users through interaction with HS **202**; and defining of an information schema that allows membersites to request information in a standardized

manner from a plurality of homesites. Root **210** also provides a mechanism for MS **206** to obtain an encryption certificate from HS **202** and be guaranteed of its authenticity. Root **210** administers the domain root.net, and is thus able to add and remove DNS lookup entries to include or exclude entities from identity management network **212**. In this 5 fashion a shadow domain is administered by root **210** in identity management network **212** to allow membersites and homesites to confirm that the other party in an authentication or information exchange is still in the network. Root **210** also preferably provides HS **202** with a signed assertion to provide a membersite along with authentication of a user, that identifies the homesite authorized to authenticate the user.

10 One skilled in the art will readily appreciate that the elimination of trust relationships between IDPs eliminates many of the scalability issues associated with this model. A single root **210** can administer a domain large enough for a vast plurality of homesites, which allows each membersite in the shadow domain to authenticate user information with each homesite.

15 To understand how the distributed hierarchical structure operates a number of standard operations will now be described. One skilled in the art will appreciate that these methods are merely exemplary and should not be viewed as limiting of the scope of the present invention.

20 As one skilled in the art will appreciate, identity management system **212** preferably identifies each user with a unique identifier. Whereas prior identity management systems have assigned PUIDs, a presently preferred embodiment of the present invention allows a user identity to be globally unique, associated with a single HS, and portable so that it can be moved to another HS. To implement this, each user is assigned a globally unique identifier (GUID) that is assigned by Root **210**, and associated 25 by Root **210** to both a user and a HS. If the user later wishes to change homesites, root **210** can authenticate that request and direct the current HS to forward all information about the user to the new HS. When a user registers with a MS for a service, or to complete a transaction, the GUID is provided to the MS, so that the MS can easily identify the user even after a HS change. In user interactions with the HS, the HS allows a user to associate 30 a user-friendly identifier, much like the user ID of the prior art, with the GUID for ease of identification. Given a set of unique user ID and password combinations, or other user

authentication mechanisms, HS **202** can authenticate user **200**, and provide the associated GUID to MS **206** along with a root signed assertion that HS **220** is authorized to authenticate the user. Thus, user **200** interacts with HS **202** using a user friendly userid, but to all other systems in identity management network **212**, user **200** is represented by a  
5 GUID. GUIDs are assigned by Root **210**, and it is preferable that they are assigned only when HS **202** is able to provide a valid email address for user **200** that can be verified by root **210**. Verification of the validity of an email address is preferred to ensure that HS **202** does not inappropriately request or create GUIDs for users who are not interested in joining identity management system **212**.

10 Figure 6 is a flowchart illustrating the steps used in the registration of user **200** in the identity management network. Because each GUID is associated with a homesite and a homesite specific user identifier, it is possible for each homesite to employ its own method of determining a user ID suitable for each user. GUIDs are assigned by root **210** to ensure their uniqueness across the network and to ensure that a homesite is not creating fictitious  
15 users in the network. In step **220**, user **200** registers at homesite **202** and requests a homesite specific user ID to which a GUID will be associated. In making this request, user **200** provides homesite **202** with a valid e-mail address. Homesite **202**, prior to obtaining a  
GUID, communicates the user e-mail address to root **210** and requests that a GUID to be  
assigned to this user e-mail address in step **222**. Upon receiving the GUID assignment  
20 request from homesite **202**, root **210** verifies the validity of the e-mail address in step **224**  
by sending an authentication challenge to the e-mail address. User **200** receives the  
authentication challenge in the transmitted email and communicates with both root **210**  
and homesite **202** in step **226** to prove the validity of the e-mail address. Upon successful  
receipt of the challenge response, root **210** assigns the e-mail address a GUID, and  
25 associates with that GUID both the valid e-mail address and a homesite identifier  
associated with the homesite that requested the GUID. The GUID is preferably stored by  
HS **202** in an assertion signed by root **210** that associates HS **202** with the GUID for proof  
to a MS that HS **202** is authorized to authenticate the GUID. A similar assertion  
associating the GUID and an email address can also be stored. These assertions are  
30 preferably signed and provided with an expiry date to ensure HS **202** does not have the  
ability to authenticate a user after the user has moved their GUID to another HS In another

embodiment, When an entity joins the identity management network **212** as a homesite, the homesite can demonstrate to the satisfaction of root **210** that the email addresses of existing accounts are valid, and without requiring the transmission of a challenge to the email address, root can issue GUIDs for each existing account. This allows a homesite 5 with an existing user base to join the identity management network **212** without having each of its existing users respond to a challenge email. To demonstrate the validity of the email addresses to root **210**, the homesite can provide proof of prior transmissions to the user as evidence of the validity of the email address.

Because the trust relationship is between user **200** and HS **202**, it may be desirable 10 for the challenge email to be branded under the identity of HS **202**. To accomplish this, along with the request for a GUID, HS **202** can provide root **210** with an email template for use with the challenge. Thus, the provided template will allow root **210** to send an email that will be branded by HS **202**. The template will allow HS **202** to ensure that user 15 **200** is presented with the challenge email having the logo of HS **202**, and that the challenge email is presented in a language specified by HS **202**. This ensures that the sign in process is seamless to user **200**.

In a presently preferred embodiment the step of transmitting a challenge in an email message in step **224** is performed by transmitting a challenge encoded URL to the user. In step **226** the user responds to the challenge by clicking on the URL, and is directed 20 to the destination address. The ability of user **200** to click through a link is considered sufficient proof that a valid user has received the email message. Root **210** will not issue a GUID to HS **202** until it receives confirmation that the user has clicked through. This can be achieved either by having the challenge URL direct user **200** to root **210**, which then 25 redirects user **200** to HS **202** along with a GUID, or the challenge can direct user **200** to HS **202** and provide HS **202** with the challenge response to provide to root **210** on behalf of user **200**. The URL can be directed to HS **202** at either its conventional address or at its shadow domain address to serve as a further guarantee that HS **202** is in the identity management network **212**.

In a presently preferred embodiment either the root **210** or the homesite **202**, upon 30 verification of the user **200**, provides user **200** with a cookie that will be accessible to any member of the shadow domain, which constitutes homesites, membersites and root **210**.

The placement of the cookies is optional step 228. This cookie is preferably referred to as the HS cookie and identifies the homesite that should be used to authenticate the user. In a presently preferred embodiment, the homesite cookie provided to the user identifies the homesite by providing an https URL which provides MS 206 with the location that user 5 200 should be redirected to, and additionally provides MS 206 with the location that the HS certificate can be obtained. In another embodiment the homesite cookie can provide a number of URL's including one indicating where to redirect the user and one indicating where MS 206 can obtain a certificate from the homesite. Obtaining the HS certificate is important for verification of signatures as is described below. In another preferred 10 embodiment, the cookie both identifies the homesite 202 and includes an assertion by root 210 that the identified homesite is the homesite that can authenticate the user. One skilled in the art will appreciate that MS 206 can obtain information about where to redirect the user from what is referred to as a command URL, while information about where to obtain the HS certificate can be obtained from a certificate URL. Both these URLs can be in the 15 homesite cookie, they can be provided in the DNS system, and the command URL can additionally be provided in the HS certificate. Thus, the homesite cookies may reference a location from which the certificate can be obtained, and in the certificate MS 206 will find the location of HS 202, or only part of a URL will be in the cookie, and based on the URL fragment, MS 206 will add on known prefixes and suffixes to create both the command 20 and certificate URLs.

The above described registration process will now be described from three perspectives, the perspective of the user 200, the homesite 202 and finally root 210. From the perspective of user 200, user 200 visits homesite 202 and requests an identification management account. In making this request, user 200 provides a valid e-mail address and 25 is informed that to complete the process, an e-mail message is being sent to the provided email address. Upon receipt of this e-mail message, user 200 responds to the challenge, preferably by clicking on the URL and thus verifying the validity of the e-mail address. At this point, user 200, either directly or indirectly, connects to homesite 202 and an identity management account is established. Thus, from the perspective of user 200, registration 30 for an account is simple process that transparently involves root 210 and thus does not rely upon user 200 trusting root 210 at all. Instead all trust issues are related to user 200

trusting the homesite 202. From the perspective of homesite 202, homesite 202 receives a request for a new identity management account from user 200, this request being accompanied by an e-mail address. The e-mail address is then forwarded to root 210 along with a request for the assignment of a GUID. Homesite 202 then receives the GUID upon 5 successful response to a challenge. In one presently preferred embodiment the response to the challenge is provided to the homesite 202 by the user 200 via the re-direction URL. This challenge response is then transmitted by the homesite 202 to the root 210, and in response root 210 provides the homesite 202 with a GUID to associate with the user 200. In an alternate embodiment, the challenge response is provided to the root 210 by the user 10 200 directly, and the homesite 202 receives a GUID when the user 200 is re-directed to the homesite 202 by the root 210. One skilled in the art will appreciate that communications between the root 210 and the homesite 202 for the purposes of transmitting the actual GUID are preferably performed in a manner that renders the communication transparent to the user. As will be apparent to one skilled in the art, passing information transparently 15 between root 210 and HS 202 can be achieved using encoded URLs in redirections, redirecting the user with a post based HTTP request, user redirections with cookies as a transfer mechanism, and back channel communications among other known techniques. These same channels can be used for communications between homesites and membersites in later methods.

20 From the perspective of root 210, root 210 receives a request from the homesite 202 for a new GUID to be associated with the provided e-mail account. To verify that the e-mail account is valid the root 210 transmits to the e-mail account an e-mail message including a challenge. Preferably the challenge is an encoded URL that will be clicked upon by the user 200. Upon user 200 clicking on the challenge encoded URL, root 210 25 will receive a challenge response, either from the user 200 or the homesite 202. Upon receipt of this challenge response, the root will assign a GUID to the e-mail address, and associate it with the homesite 202. This GUID will be transmitted to the homesite 202, using known techniques.

One skilled in the art will readily appreciate that this process ensures that the root 30 is not assigning GUIDs to a homesite without a valid reason. This maintains the integrity of the identity management system.

Another role played by the root **210**, in addition to the assignment of GUIDs, is the definition of a schema which HS **202** will use to store identity data. A defined schema allows MS **206** to request subsets of the user information, and to make any request using predefined field names to ensure a proper response. It should be noted that in a presently preferred embodiment there is no requirement for HS **202** to store the full schema, and in the event that it is asked to provide information about a user that it does not store, HS **202** will either inform user **200** that it does not store the requested information and prompt the user to provide it and then pass the stored and obtained information to MS **206**, or HS **202** will provide MS **206** with the subset of the requested information that is stored, and leave it to MS **206** to prompt user **200** for more information. As a result of not requiring HS **202** to store the full schema for any user, root is able to add new fields to the schema at regular intervals. This allows root **210** to add new fields to store information about new reward programs, or unanticipated requests from membersites. In prior art systems, a schema once defined became static, and the ability to add new fields to the schema was difficult if not impossible. By not forcing a homesite **202** to store the full schema, root **210** can update the schema at any time and rely upon homesites to connect and request the new schema at their convenience. Thus, homesite **202** can check for a new schema at regularly defined intervals, whenever a new GUID is requested, or accompanying any other transaction with root **210**, or using any other schedule defined by homesite **202**. In a presently preferred embodiment the schema is stored as an extensible mark-up language file that can be queried to obtain a variety of information.

Figure 7 illustrates a method by which a homesite **202** is able to obtain an updated schema from the root **210**. In step **230**, the homesite **202** transmits a schema update request to the root **210**. In response to the receipt of the schema update request from the homesite **202**, the root **210** preferably determines the last transmitted schema in step **232**. This preferably entails determining a last transmitted schema date through analysis of the transmitted update request. In step **234**, the root **210** transmits a new schema to the homesite **202** that transmitted the update request. In a presently preferred embodiment, the root **210**, using the determined last transmitted schema, transmits only an updated information list, including the changes to the schema, without transmitting the entire schema. In step **236**, the homesite **202** receives the transmitted new schema information

and adopts the new schema elements, and associates unpopulated fields corresponding to each of the new schema elements with each user account. Any of a number of known techniques can be used to populate the new fields, and one skilled in the art will appreciate that the following examples are merely exemplary, and not exhaustive. In one 5 embodiment, upon receiving a new schema, the homesite 202 will e-mail the user to notify them that additional information can be stored in their user profile. In an alternate embodiment, at the time of the user's next log-in to the homesite 202, the user will be notified that new schema fields exist and will be prompted to click on a link that will allow the user to populate the new fields.

10 One skilled in the art will appreciate that a number of similar techniques can be used to transmit the new schema to membersites. However, it is likely that membersites will require operator interaction to incorporate requests for new schema held information when a new schema is received.

15 A method of a membersite requesting authentication of a user is described in Figure 8. To provide single sign on abilities to users, the present identity management system preferably employs the homesite cookie provided to user 200 in step 228 of Figure 6. This cookie preferably identifies the homesite associated with the GUID. To ensure that this information is available to all sites in identity management network 212, the cookie is preferably readable to sites in the domain root.net. Thus, if a membersite attempts to 20 access the cookie, and is not in the shadow domain, the attempt to read the cookie will be rebuffed. However, if membersite 206 is part of the shadow domain, it will obtain a GUID and an indication of the homesite associated with the GUID in step 238. As described earlier, MS 206 must redirect to the shadow domain to retrieve the cookie. This can either be done with the user clicks a link, or at a previous time. The homesite cookie identifies 25 the homesite that can authenticate user 200. Upon determining that homesite 202 is identified in the homesite cookie, membersite 206 re-directs the user to homesite 202 with an authentication request in step 240. To retrieve the authentication request, HS 202 must be in the shadow domain. Thus MS 206 can redirect user 200 to HS 202 in the shadow domain 214, or in the primary domain 204. If HS 202 receives user 200 in the primary 30 domain 204, it will redirect user 200 to the shadow domain 214 so that it can retrieve the authentication request. If homesite 202 is no longer in the shadow domain, the redirection

to retrieve the cookie will not be resolved to a valid address, and thus the operation will fail. However, if homesite 202 is in the identity management network 212, the redirection request will allow shadow domain address 214 to be resolved to an address that results in user 200 being transferred to homesite 202. In step 242, the user provides homesite 202 with authentication credentials. Upon completion of the authentication homesite 202 re-directs the user to membersite 206 either in the shadow domain 216 or in the primary domain 208, in step 244 and provides membersite 206 with user authentication information that is accessible in shadow domain 216. Thus depending on the redirection provided by HS 202, MS 206 may be required to redirect user 200 to the shadow domain 216. Upon receipt of the authentication and the re-direction of the user, membersite 206 allows user 200 to log-in, in step 246. In a presently preferred embodiment, the authentication will be signed by HS 202, and will be accompanied by an assertion signed by root 210 that HS 202 is authorized to authenticate the GUID.

One skilled in the art will readily appreciate that communications between homesite 202 and membersite 206 can be effected in any of a number of ways. In a presently preferred embodiment, membersite 206, upon detection of the homesite cookie, re-directs the user to homesite 202 in the shadow domain as described in step 240 and requests information by providing user 200 with a second cookie to identify the fields in the schema that are required to allow the user to log-in to membersite 206. Upon receipt of the re-directed user in step 244 and the subsequent authentication, homesite 202 in step 244 will preferably re-direct the authenticated user to membersite 206 in the shadow domain, and provide the authentication information either via the cookie or other known techniques.

The above described method will now be described from the perspective of the user, the membersite, the homesite, and finally from the perspective of the root. From the perspective of the user, the user visits a membersite and preferably clicks on a link indicating that they are part of the identity management network. This link re-directs the user to homesite 202 where credentials are presented to verify identity. Upon successful authentication of identity, the user is re-directed back to membersite 206 and allowed in.

From the perspective of a membersite, membersite 206 receives an indication from a user that it is registered with a homesite in the identity management network.

Membersite 206 then requests and receives the cookie from user 200 in the shadow domain. This cookie identifies homesite 202 as the homesite that can provide authentication. Membersite 206 re-directs user 200 to homesite 202 and requests that homesite 202 authenticate the user 200 and re-direct the user back to membersite 206 after 5 authentication. Membersite 206 then receives the user 200 via a re-direction URL and additionally receives an indication that the user has been authenticated. The indication is preferably accessible in the shadow domain 216, and is accompanied by a root signed assertion as described above

From the perspective of homesite 202, user 200 establishes a connection as a result 10 of a redirection from membersite 206. User 200 typically provides a request from membersite 206 to authenticate the identity of the user and re-direct the user upon authentication back to membersite 206. Typically, this request for authentication and re-direction is stored in a cookie provided by the user. Homesite 202 then requests that the user supply credentials to authenticate their identity. Upon receipt of these credentials, and 15 authentication of the identity of user 200 based on the presented credentials, homesite 202 then re-directs the user to membersite 206 and provides membersite 206 with an indication that the user has been authenticated.

Root 210 is called upon twice during this process. In both cases, interaction with root 210 is performed to allow the user to be re-directed to a shadow domain name. Thus, 20 when membersite 206 re-directs the user to homesite 202 in the shadow domain, root 210 receives a request for shadow domain name resolution. Upon receipt of this request, root 210 determines the present state of the shadow domain entity. Based on the shadow domain entity's present state, root 210 resolves the shadow domain name to an address. Thus, if homesite 202 is presently a part of the identity management network, its shadow 25 domain name is resolved to the same IP address that its real domain name would be resolved to. However, if homesite 202 has been removed from the identity management network, resolution of the domain name will result in either an error, or re-direction to a page explaining to the user that homesite 202 is no longer part of the identity management network. Similarly, when homesite 202 re-directs the user to membersite 206, root 210 30 receives a shadow domain name resolution request, determines the present state of the

shadow domain entity and based on that determined present state resolves the shadow domain name address.

One skilled in the art will readily appreciate administration of the shadow domain by root **210** is achieved by maintenance of sub-domains under the root.net domain. Thus, 5 the addition of either a membersite or a homesite to the identity management network entails root **210** modifying a domain name server look-up table to associate an IP address or domain name with a shadow domain name. One skilled in the art will appreciate that due to synchronization of domain name servers on a public network such as the internet, the role of root **210** in resolving the domain names can also be performed by a number of 10 domain name servers that receive data from the root. However, one skilled in the art will appreciate that from a logical level due to the synchronization of domain name servers, all shadow domain resolution requests can be considered to be resolved by root **210**.

In addition to providing a single sign on functionality, the present invention provides a mechanism for user **200** to store identification information with HS **202**, and 15 have HS **202** provide the information to MS **206** to facilitate registration for the services offered by MS **206**. This facility appears to user **200** to be a form-filling functionality.

Figure 9 illustrates a method of providing identity information stored by HS **202** to MS **206**. This method allows user **200** to begin a sign up procedure at MS **206**, and have HS **202** fill in the fields in the registration form for which there is a corresponding stored 20 value. Much as with the single-sign on facility provided by the method of Figure 8, the form-filling method of the present invention starts with user **200** indicating to MS **206** that identification information can be provided by a homesite in identity management network **210**. This indication preferably takes the form of clicking on a hypertext link that indicates affiliation with a homesite. After receiving the user notification, MS **206** retrieves the 25 cookie provided by user **200** in the shadow domain **216** and determines a homesite for user **200** in step **248**. User **200** is then redirected to HS **202** along with an information request in step **250**. The information request contains a request for the information needed to fill out fields the form, it does not have to include a request for all the information on the form, and does not need to request all the information stored by HS **202**, thus, MS **206** is 30 able to request a subset of the information stored by HS **202**. HS **202** preferably authenticates user **200** upon receiving the redirection in step **252** to ensure that no one is

fraudulently requesting the information of user **200**. Upon authentication, user **200** provides HS **202** with authorization to transfer the requested information to MS **206**. Once again this step is considered optional, through preferred, as it can depend on the terms of service agreed upon between HS **202** and user **200**. HS **202** then redirects user **200** to MS **206**, preferably in the shadow domain to ensure that MS **206** is in the identity management network **212**. Along with the redirection, HS **202** provides MS **206** with the requested information in step **254**. In step **256**, MS **206** receives both user **200** being redirected from HS **202**, and the requested information. If HS **202** has previously authenticated user **200**, HS may not re-authenticate user **200**, and instead will only verify user **200** has been authenticated.

One skilled in the art will appreciate that the data stored by HS **202** can be requested by MS **206** in a number of ways. For simply queries, MS **206** can request name and value pairs from HS **202** provided in such a fashion that HS **202** can provide a response in a format that allows MS **206** to receive the information in a desired order. Additionally MS **206** can request information using structured queries to HS **202**. These structured queries are typically replied to using XML based results, though other known techniques of structured replies can also be provided. Queries can also be made to information that HS **202** determines dynamically, or to information that is not directly hosted by HS **202**, and instead is hosted by a third party that HS **202** maintains a link to. For simple queries based on name value pairs, MS **206** can specify the name with which a value is returned so that a value stored in the schema under one name can be returned to a form provided by MS **206** using the form based names used by MS **206**. This allows membersites with pre-existing data collection systems to request information from homesites and receive data via a POST operation to populate the fields in their HTML form. This allows MS **206** to join identity management network with minimal modification to their existing pages. Additionally, in a presently preferred embodiment, the simple query will include a redirection URL value, so that HS **202** can redirect user **200** to the next page in the data collection phase at MS **206**. To enable the automated form filling, HS **202** will provide MS with the requested information associated with the provided names, optionally in the requested order, and will direct user **200** to the next page in the sign-in procedure by providing a redirection URL that automatically posts the

provided data to MS 206. For structured queries, HS 202 will preferably redirect user 200 to MS 206 with a POST operation that provides the requested structured data, preferably in the form of an XML file. HS 202 may store machine readable data, such as a photo of the user, and can provide it in response to a query from MS 206. Dynamic data may 5 include such data as a length of time since the last authentication, and can be provided in response to either simple or structured queries. As noted above, HS 202 can store data as a reference to another site, for example, user 200 may have calendar data stored with a third party to which HS 202 stores a link. MS 206 may be an airline that provides a structured query to obtain an XML based report on the availability of user 200 on a given day to 10 schedule a flight. HS 202 can provide either a reference to the calendar site, or can query the calendar site obtain the results and provide them to MS 206. Communication with third parties, such as a calendar site is preferably achieved using defined protocols.

Other data that can be provided in response to queries includes third party assertions that are associated with the GUID. Assertions have previously been discussed in 15 reference to the assertion signed by the root 210 that asserts that a homesite is authorized to authenticate a GUID, but assertions can be provided by other entities as well. Government agencies may provide an assertion associating a birth date with a GUID, so that MS 206 can receive a signed assertion from a trusted authority that user 200 is above a certain age. A mechanism for MS 206 to obtain a certificate or public key with which to 20 authenticate the assertion is discussed below. Other assertions may include indications that users have achieved a premium service level with a reward program. This assertion could be used by a membersite to provide user 200 with a discount for a service based on the premium reward membership. Other assertions, signed by third parties, will be apparent to those skilled in the art. Assertions can either be stored by HS 202, or they can be stored as 25 links by HS 202, to allow MS 206 to retrieve the assertion directly from the third party.

Whereas simple queries are commonly responded to through URL encoding, extensible queries are preferably responded to by passing information to MS 206 through a HTTP post operation.

Because the schema used to store user information is dynamic, a mechanism for 30 acquiring user information after an initial sign up is required. While it is envisaged that HS 202 can prompt user 200 to add information during an authentication or information

request, the present invention provides a novel method of obtaining user information for storage by HS 202. This method is illustrated in the flowchart of Figure 10.

The present architecture allows the user to populate schema fields or modify existing information stored by the homesite 202 from participating membersites 206. This 5 method is illustrated in Figure 10. Upon requesting and receiving information about the user from the homesite 202, the membersite 206 determines in step 258 that it requires more information, and thus prompts the user 200 to enter this information, in an alternate embodiment, MS 206 asks the user to confirm the information provided by HS 202. In step 250 the user provides this information to the membersite 206 and indicates, preferably 10 by clicking on a hypertext link, that this information should be transmitted back to the homesite 202. At this point, the membersite 206 re-directs the user to the homesite 202 using the shadow domain address and transfers to the homesite 202 the information provided by the user. The transfer of information provided by the user can take place using back channel communication, an encoded URL in the form of a simple query, or in 15 cookies carried by the user. After receipt of both the re-directed user, and the transmitted information, the homesite 202 presents the user with the information, and asks for approval of the information. Upon receipt of the approval of the information from the user 200 in step 254, the homesite 202 stores the information in the schema. At this point, the user is re-directed back to the membersite 206 in step 256. In another embodiment, MS 20 206 determines that as a result of its interaction with user 200 that new information is available that should be provided to HS 202. MS 206 then requests user authorization to transfer the data back to HS 202, as in step 260, and the process continues as described above. As an example of the alternate embodiment, MS 206 is an airline that has booked a 25 flight for user 200. MS 206 has structured information that should be provided to HS 202 to store in the calendar of user 200. The structured data is preferably transferred as an XML file containing the flight number, destination, takeoff and landing times and other related information. HS 202 can respond to the update by either storing the data if it hosts the calendar for user 200, by redirecting the information to the calendar provider if it is a third party, or by providing MS 206 with an address to which the information should be sent. Thus the information provided to HS 202 can be structured or simple, and it can be 30 either stored or referenced data. In a presently preferred embodiment, MS 206 does not

require user authorization for all updates of HS **202** information. In the above example of an airline booking, if the flight is delayed, MS **206** can preferably automatically update HS **202** without requiring user approval.

As noted earlier, one of the benefits of the present invention is that the information stored by a homesite is portable to another homesite. There can be any of a myriad number of reasons that a user would want to move their data from one homesite to another, including cost, the amount of information a homesite is willing to store, and the terms of service the homesite operates under. Whereas in prior art systems there was either no equivalent to transfer data to, or the data was non portable, the present system ensures the portability of user data by assigning user **200** a unique GUID and requiring that HS **202** stores user information in a defined schema. Thus, to change a homesite, user **200** visits a second homesite and indicates requests a new account to be associated with an existing GUID. By maintaining the same GUID, a user will be able to maintain any accounts membersites that have stored information using the GUID as an identifier. Much as with the registration process, root **210** issues a challenge to user **200**, requiring the user to respond to the challenge to ensure that a misbehaving homesite is not attempting to steal users from another. The transfer of registration process is identical in the challenge response phase, and upon successful completion of the challenge response, root **210** issues a directive to the existing homesite to transfer all schema related information to the new homesite. This can be accomplished either using back-channel communications, URL encoding, or preferably by root **210** redirecting user **200** to the original homesite, having the original homesite provide user **200** with a cookie containing all stored personal information, and then redirect user **200** to the new homesite. The redirection from the first homesite to the second homesite can be accomplished by redirecting the user **200** to root **210** so that the original homesite does not know where the user has gone to. Upon being, either directly or indirectly, redirected to the new homesite, user **200** provides the cookie that stores all the schema related information, and receives a new cookie confirming the GUID, and indicating that the new homesite is the site to be associated with the GUID.

In a presently preferred embodiment, to obviate the need to retransmit challenge emails, the newly selected homesite can direct the user to the initial homesite for

authentication. Successful completion of this authentication can be considered by root **210** as proof that the user has the authority to transfer the GUID to another homesite.

Whereas prior art methods of identity management provided membersites with PUIDs, the present invention provides GUIDs that due to their global nature can be used 5 to obtain third party assertions. Puids cannot support third party assertions without the IDP sharing the PUID mapping with a third party, thus negating the purpose of a PUID. To provide user **200** with the advantages offered by PUIDs, HS **202** can allow a user to obtain multiple GUIDs. By obtaining multiple GUIDs, user **200** can create a plurality of online personas so that different membersites cannot correlate behaviour online. This provides 10 user **200** with the option of obtaining the security of PUIDs, while still retaining the benefits of GUIDs. To allow the management of multiple GUIDs, user **200** will be prompted by HS **202** upon authentication as to which GUID should be provided to a membersite. This allows a user to provide HS **202** with one set of information, and have 15 different profiles set up for each GUID. Thus a work based persona with a GUID can default to providing an office phone number and address when a membersite requires a phone number and address, while a home based persona with a different GUID can default to providing a home phone number and address when requested.

As discussed above, assertions are preferably provided by root **210** to provide proof to a membersite that HS **202** is authorized to authenticate a GUID. Preferably this 20 assertion is signed using a private key or certificate, and the signature can be verified using a public key or certificate. The certificate is preferably obtainable through contact with root **210** over a secure data channel. To ensure that the certificate has not been tampered with, the certificate of root **210** is preferably signed by a first certificate authority (CA), and transmitted to a requesting party over an SSL link that is signed by a 25 second distinct CA. This double chain of signatures requires that both the first and the second CA be compromised for a malicious party to be able to impersonate root **210**. The authentication information provided by a homesite is preferably signed by the homesite, so that it too is a credential. This information is preferably signed by the homesite, so that the membersite can be sure that it has not been tampered with, or that the homesite is being 30 impersonated by a third party. To verify assertions made by the homesite, a membersite can obtain a certificate from the homesite over an SSL connection signed by a CA, with

the homesite certificate signed by the root. Because the CA and the root are distinct, there is another double chain for security, requiring a breech of security at both the CA and the root. Third party assertions are preferably signed, with a certificate available over an SSL connection, the certificate signed by root or a CA, and the connection signed by a CA distinct from the one that may have signed the certificate. The above double signature transmission is preferred for the verification of certificates transmitted in identity network 5 **212**.

In a presently preferred embodiment, when presented with a signed assertion, MS 10 **206** will obtain the certificate used to verify the signature and cache the certificate. In the next signature verification that uses that certificate, MS **206** does not have to re-request the certificate, but must be sure that the certificate is up to date. To do this, MS **206** performs 15 a DNS txt lookup on the shadow domain name of the certificate holder. Root **210** in providing DNS services for the shadow domain maintains in each entity's txt DNS field their certificate number. If the value returned from the DNS lookup is identical to the certificate number, MS **206** can verify the signature, if the certificate number is different, MS **206** then discards the cached certificate and requests a new certificate.

To allow a membersite to enter identity management network **212** without adding 20 in scripting functionality that allows key management, and shadow domain shifting, it is possible for MS **206** to have its shadow domain **216** associated with a third party that processes the reading of the homesite cookie, the redirection to HS **202** and the provision 25 of the data provided by HS **202**. Additionally, this third part can handle the signature checks required to verify the integrity of the received data. One skilled in the art will appreciate that this functionality can be provided by a single entity for numerous membersites.

One common request for existing single sign in services is the provision of a single 25 sign out facility. To provide this, a membersite that has allowed a user to sign in, preferably modifies a cookie carried by user **200**. This cookie tracks the membersites to which a user is logged in. In a presently preferred embodiment, the cookie provides a URL that will allow a user to log out. To sign out of services, user **200** returns to his homesite 30 **202** and indicates that he wishes to log out of all services, or a subset thereof. The homesite **202** can then work through the URL's provided in the cookies to allow the user

to have a single click sign off. Alternately, MS 206 can provide a logout link to user 200 that can either log user 200 out of MS 206, and remove the membersite reference in the cookie, or redirect user 200 to HS 202 so that the logout process described above can be pursued. In another embodiment, when HS 202 authenticates user 200 for MS 206, HS 5 202 can store in the user profile database a logout URL for MS 206. Thus, to log out, user 200 would visit HS 202 and request a list of sites at which a login is current, this list would also preferably provide the user with the ability to logout of any or all membersites.

The present invention provides users with simplified sign in and registration with membersites, allowing the user to visit a membersite, and indicate that they are part of the 10 identity management network. This is preferably done by clicking on either an icon or a link on the sign in page. When this link has been clicked upon, MS 206 will retrieve the cookie identifying user 200, and will redirect user 200 to HS 202. In the case of simply signing in to MS 206, where a previous registration has been made the redirection to HS 202 is simply for authentication. If user 200 has not previously registered with MS 206, 15 the redirection to HS 202 is for both authentication and for an information request. MS 206 can request a subset of the information stored at HS 202, using either a simple URL encoded redirection, or can request extensible information through the use of a query stored in a cookie carried by user 200. The redirection of user 200 to HS 202 sends user 200 to the shadow domain of HS 202, to ensure that HS 202 is still in the identity 20 management network. After providing HS 202 with authentication credentials, and any required authorization for data transfer, user 200 is redirected to MS 206. The checks to ensure that both MS 206 and HS 202 are in the shadow domain, and thus are active in the identity management system are performed transparently to the user, and allow the user a simplified process for login and registration. Through the ability of MS 206 to pass 25 information back to HS 202, user 200 is provided with a simplified mechanism for ensuring that HS 202 has updated and new information.

Because user 200 authenticates at HS 202 after a redirection from MS 206, user 200 is typically required to verify that a correct redirection has been made by checking the URL which is typically in a navigation or location bar in the browser window. To provide 30 additional security, HS 202 can store a series of user preferences, obtained from user 200, that define a user interface and experience. These preferences may include a user defined

background page colour, a customized set of icons, a user defined greeting and a user selected language interface. These preferences can be obtained from user 200 at the time of registration, stored in the user profile database, and retrieved when user 200 is redirected for authentication. If a malicious party attempts to impersonate HS 202, the user 5 defined preferences will be unavailable, and as a result, user 200 will be immediately aware that they have been redirected to the wrong site.

The hierarchical structure of the present invention provides a single point from which security breeches can be addressed, while the distributed nature of the homesites eliminates the single point of failure that releases user information. If the integrity of root 10 210 is compromised, removal of all root.net domains can be easily achieved by contacting DNS authorities, which will shut down the entire identity management network 212. This will prevent the release of any user information, and will prevent fictitious homesites from allowing user impersonation. If root 210 is comprised, there is no user specific data released as opposed to the Passport<sup>TM</sup> model. If a single homesite is compromised, its user 15 data is released, but by removing it from the shadow domain, it is prevented from providing improper authentications, as it will be unable to retrieve cookies from the shadow domain. Thus, a compromised homesite can be effectively removed from the network in the time it takes an address update to be propagated through the DNS network. In the Liberty Alliance model, which provides no single point of failure, due to the 20 complex key ring in the web of trust, there is no simple method of removing a compromised IDP from the web. Thus, the present invention, through its structure eliminates a single point of failure that will allow the release of user data, and provides a mechanism for isolating compromised homesites to prevent impersonations of users.

The above-described embodiments of the present invention are intended to be 25 examples only. Alterations, modifications and variations may be effected to the particular embodiments by those of skill in the art without departing from the scope of the invention, which is defined solely by the claims appended hereto.

What is claimed is:

1. An identity management system for providing authentication of a user to a membersite, the identity management system comprising:

5 a root server having a user database for storing a globally unique identifier associated with the user, the root server having means for providing the globally unique identifier to the user, for maintaining a list of network addresses associated with names in a shadow domain for providing to a domain name server, each name associated with either the membersite or a homesite in an identity management network, to permit the homesite to authenticate an entity accessing the membersite as the user associated with the globally unique identifier, upon user redirection to the name associated with the homesite in the shadow domain.

10 2. The identity management system of claim 1, wherein the root server includes a homesite authenticator for providing the membersite with authentication of the authority of a homesite to authenticate the entity as the user associated with the globally unique 15 identifier.

15 3. The identity management system of any one of claims 1 and 2, further including a homesite, in communication with the root server and having a user profile database, a user authentication engine, and a domain name in the namespace of the shadow domain, the user profile database for storing both the globally unique identifier and authentication 20 information associated with the user, the authentication engine allowing the homesite to authenticate the identity of the user.

4. The identity management system of claim 3, wherein the authentication information is a combination of a user ID and password.

25 5. The identity management system of any one of claims 3 and 4, wherein the user profile database further stores identity information associated with the user, and the authentication engine includes means to provide the membersite with a subset of the identity information upon authentication of the user.

6. The identity management system of any one of claims 3, 4 and 5, wherein the authentication engine provides the authenticated user identity to the membersite through providing the user with a cookie containing authentication information readable by the membersite and redirecting the user to the membersite.

5 7. The identity management system of claim 6, wherein the cookie is signed by the homesite, and includes indication from the root server that the homesite is authorized to authenticate the globally unique identifier.

10 8. The identity management system of claim 5, wherein the authentication engine provides the identity information associated with the user to the membersite through one of redirection of the user to an authentication encoded universal resource locator, and both providing the user with a cookie containing authentication information readable by the membersite and redirecting the user to the membersite.

9. A method of obtaining user authentication from a homesite in an identity management network, the method including:

15 obtaining from the user the name of a homesite that can provide user authentication based on user authentication information known to the homesite;

providing the homesite with an authentication request by redirecting the user to the homesite in a shadow domain associated with the identity management network; and

20 obtaining the authentication of the user from the homesite in response to the homesite receiving the known authentication information from the user, the authentication including a globally unique identifier associated with the user.

10. The method of claim 9 wherein the step of obtaining the name of the homesite from the user includes the membersite examining a cookie provided by the user.

25 11. The method of claim 9, wherein the step of providing the homesite with an authentication request includes the user resolving a name associated with the homesite in the shadow domain to a network address.

12. The method of claim 9, wherein the step of providing the homesite with an authentication request includes the membersite providing the user with a cookie, readable by the homesite, containing a request for authentication of the user.

13. The method of claim 9, wherein the homesite can provide both user authentication 5 information and user identity information, and the step of providing the homesite with an authentication request additionally includes the membersite providing the homesite with an identity information request.

14. The method of claim 13, wherein the step of obtaining the authentication additionally includes the obtaining identification information in response to the homesite 10 receiving the known authentication information from the user.

15. The method of claim 13, further including:

obtaining identity information not provided by the homesite; and  
providing the obtained identity information to the homesite by redirecting the user to the homesite in the shadow domain.

15 16. The method of claim 15, wherein the identity information not provided by the homesite is obtained from the user.

17. A method of performing a user authentication at a homesite in an identity management network, using the system of claim 2, the method comprising:

20 receiving from the user a request to provide authentication for the membersite; and  
providing authentication of the user to the membersite in response to receiving known authentication information by redirecting the user to the membersite in the shadow domain associated with the identity management network.

18. The method of claim 17, wherein the step of the providing the membersite with authentication of the user includes receiving from the user a user ID and password 25 combination associated with the globally unique identifier of the user.

19. The method of claim 17, wherein the step of providing the membersite with authentication of the user includes the user resolving a name associated with the membersite in the shadow domain to a network address.

20. The method of claim 17, wherein the step of providing authentication of the user 5 includes the homesite providing the user with a cookie, readable by the membersite, containing authentication of the user and the globally unique identifier associated with the user.

21. The method of claim 17, wherein step of receiving a request to provide authentication information includes receiving an identity information request.

10 22. The method of claim 21, wherein the step of providing authentication includes the providing the membersite with identification information upon receipt of the known authentication information from the user.

23. The method of claim 22, wherein the step of providing the membersite with identification is preceded by obtaining user authorization for the transfer of the requested 15 identification information to the membersite.

24. The method of claim 21, further including:  
receiving from the user, identity information obtained by the membersite; and  
storing the transferred identity information in a user profile database.

25. A method, using the system of claim 2, of obtaining a globally unique identifier to 20 associate with the user, the method comprising:

receiving a request from the user to associate a globally unique identifier with the email address;

requesting, from root server the assignment of a globally unique identifier associated with the user email address; and

25 obtaining the globally unique identifier associated with the email address in response to the user providing the root with a response to a challenge transmitted to the email address.

1/10

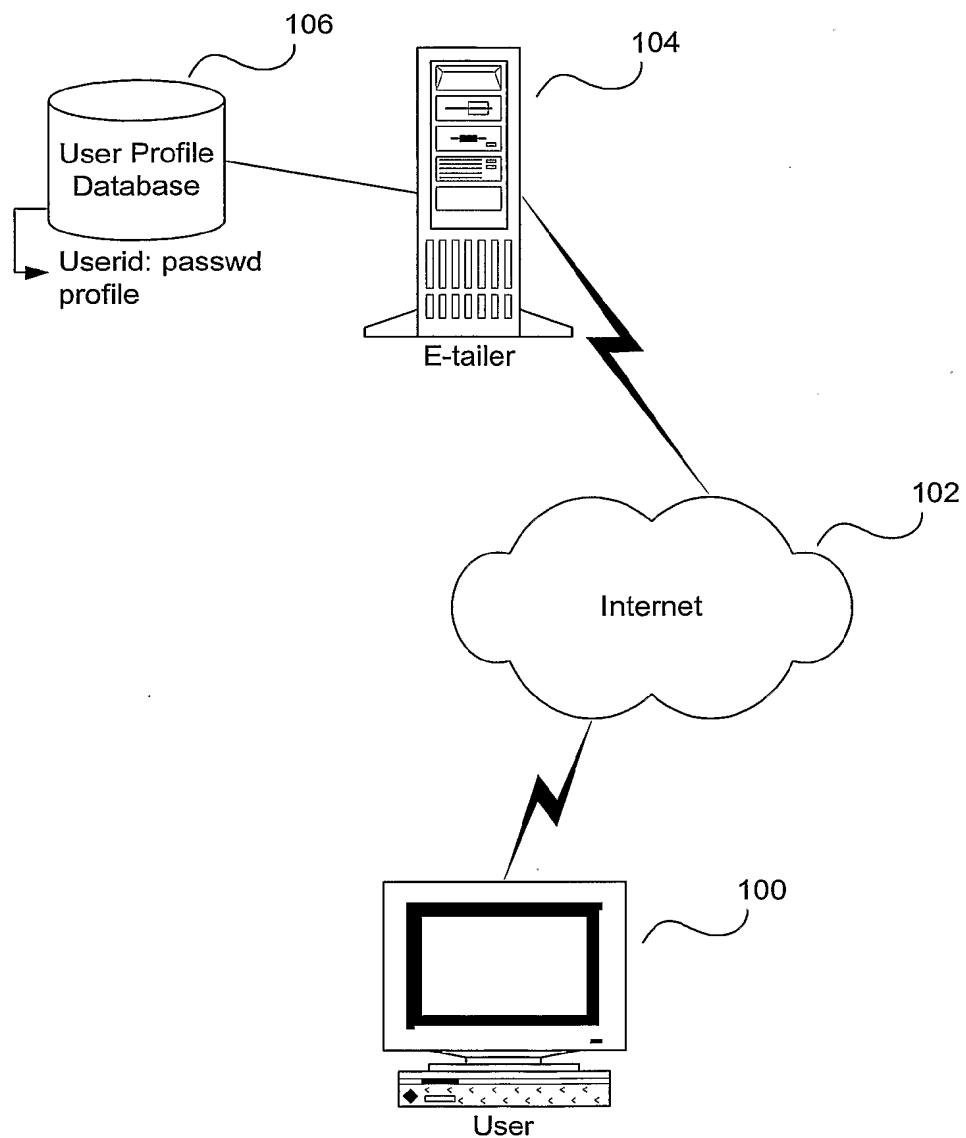


Figure 1 (Prior Art)

2/10

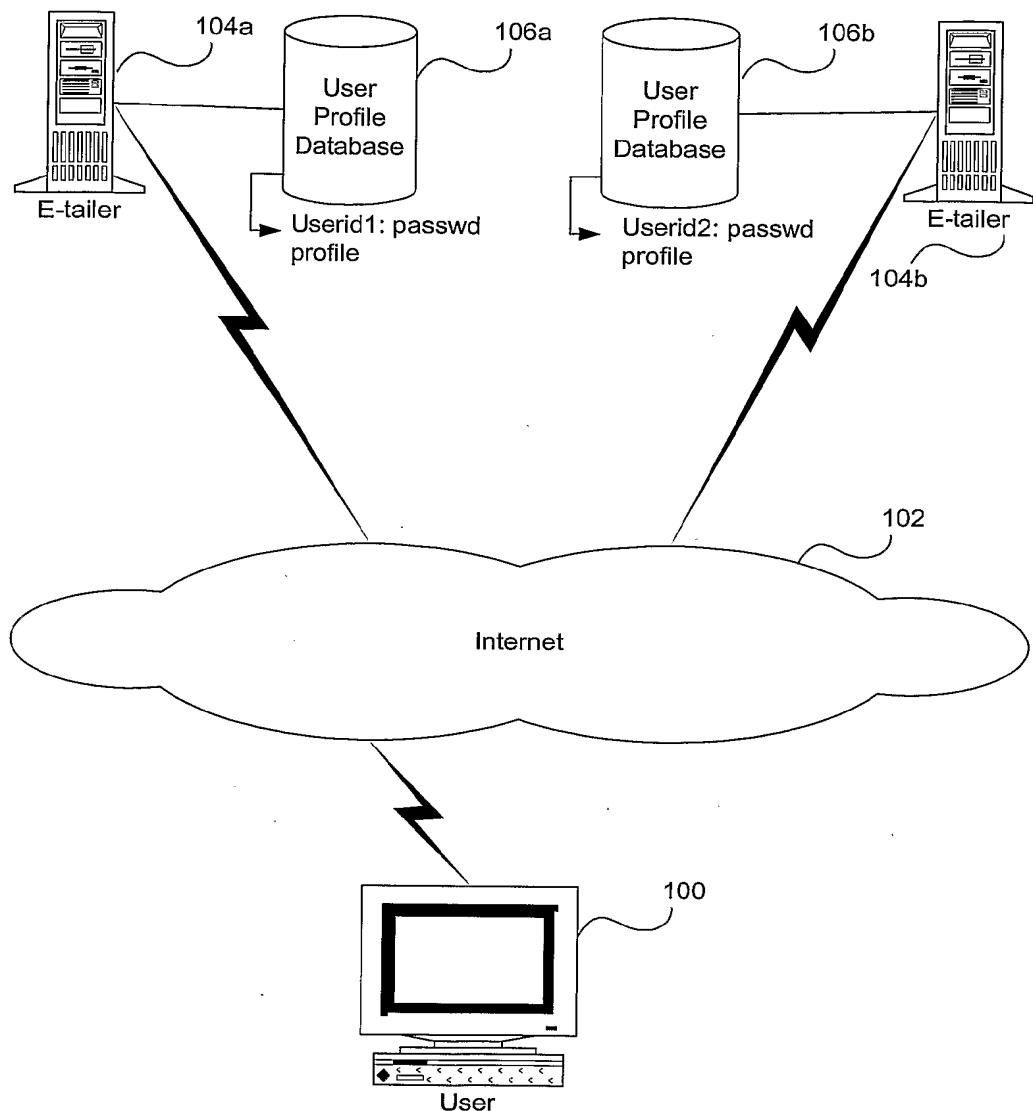


Figure 2 (Prior Art)

3/10

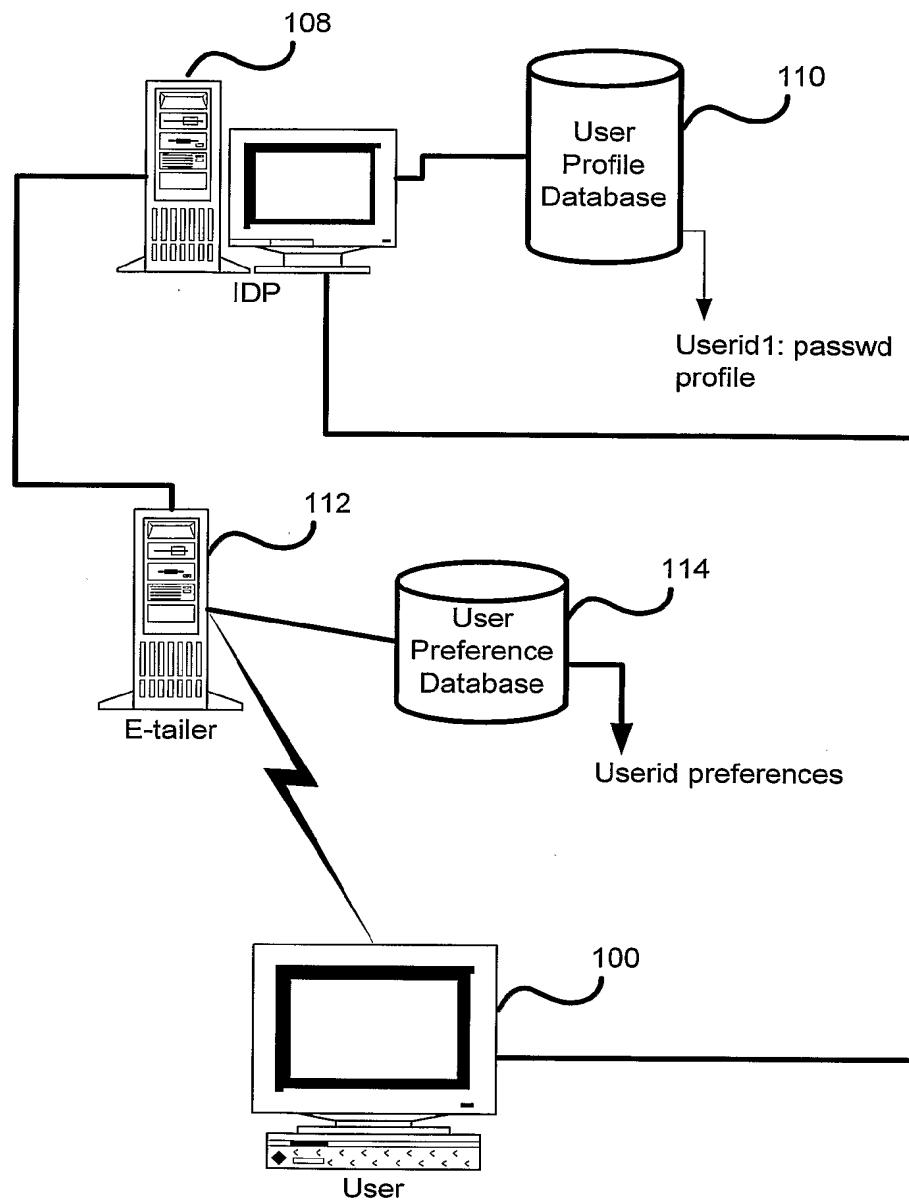


Figure 3 (Prior Art)

4/10

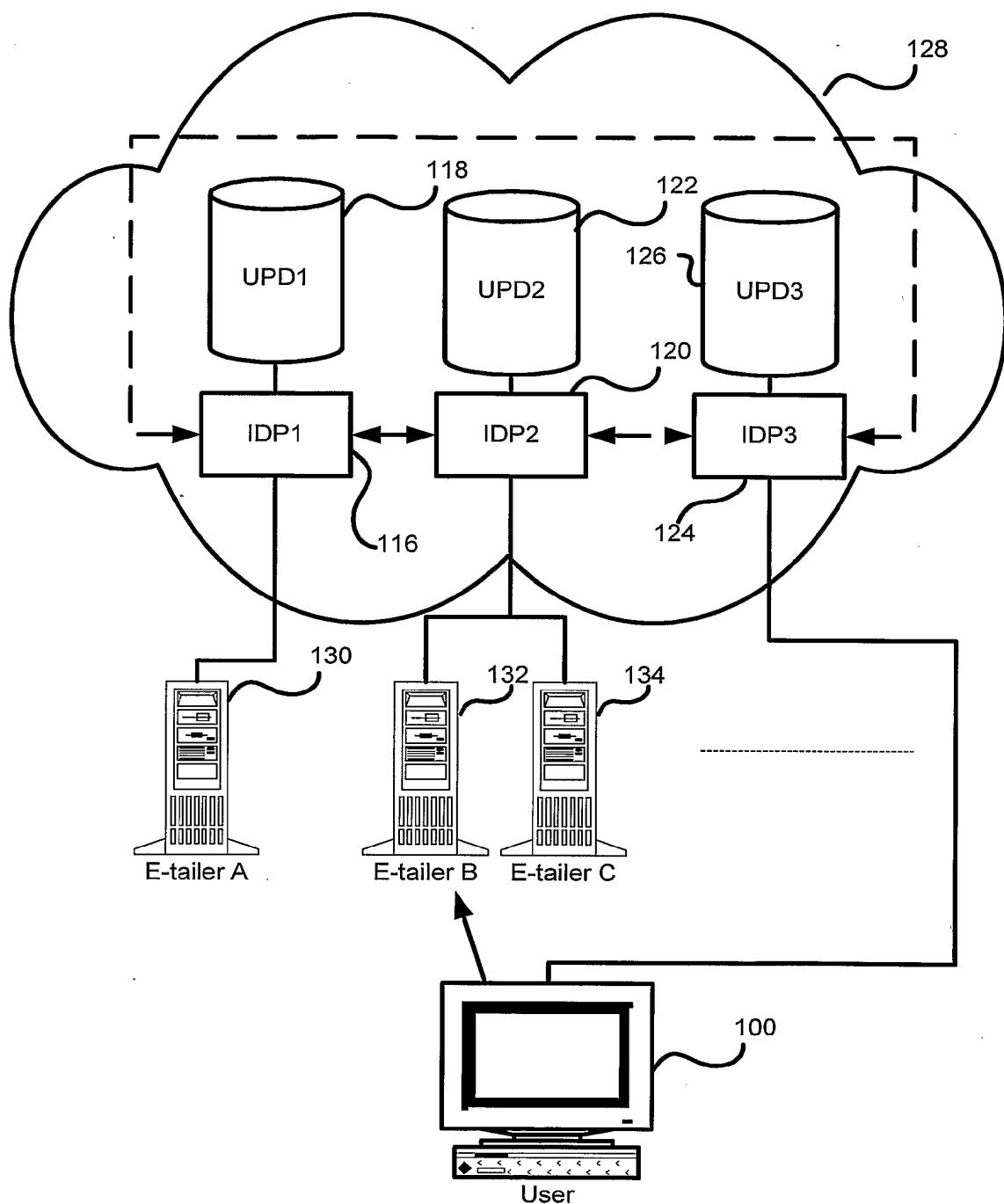


Figure 4 (Prior Art)

5/10

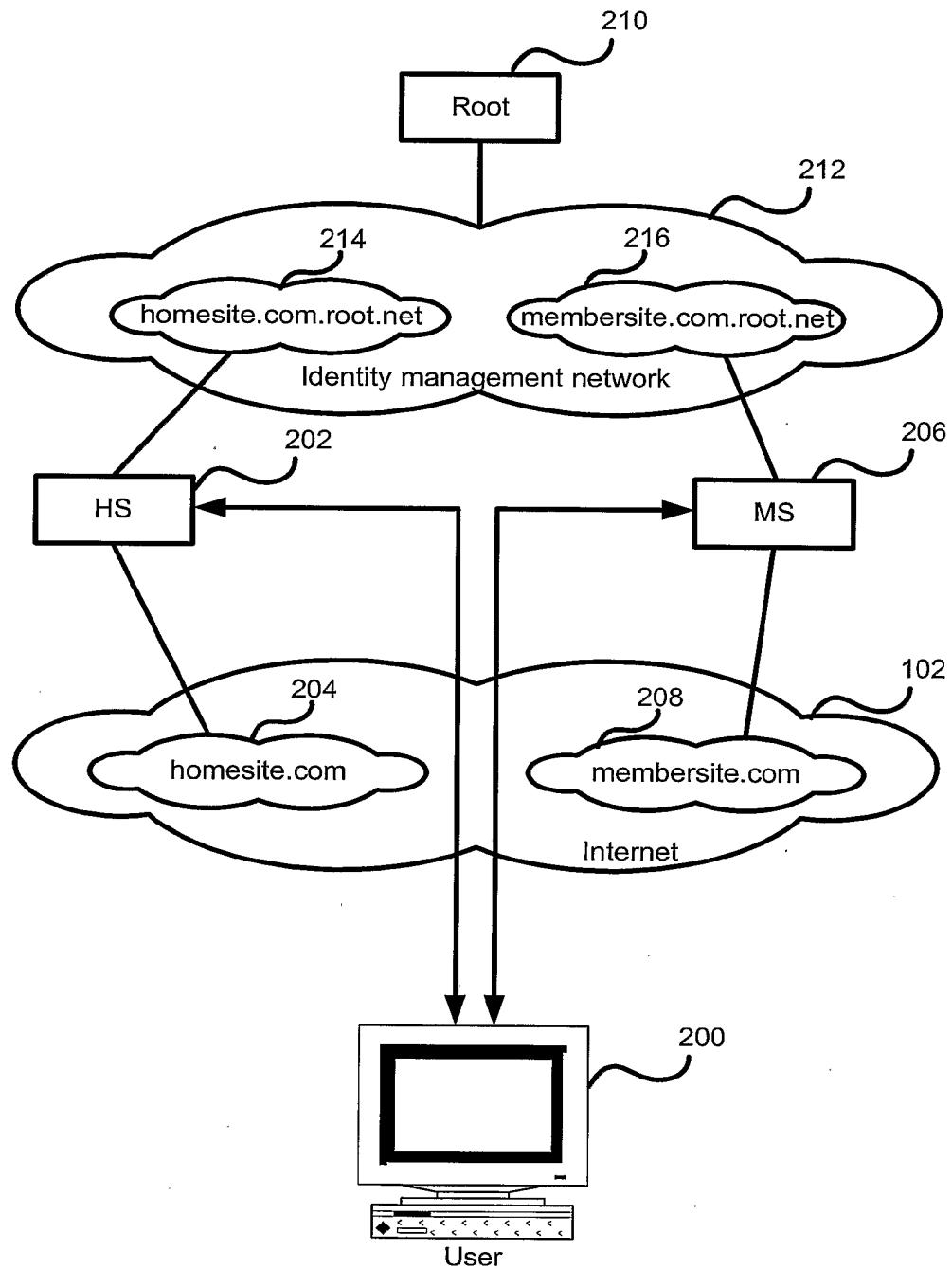


Figure 5

6/10

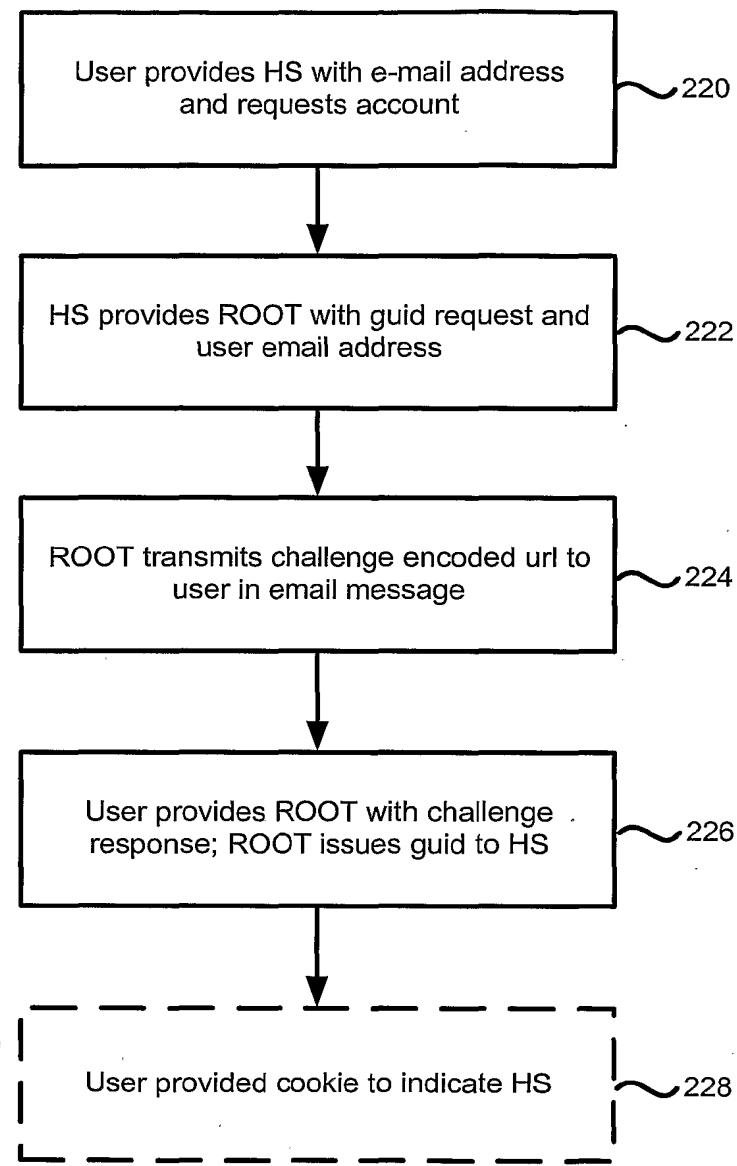


Figure 6

7/10

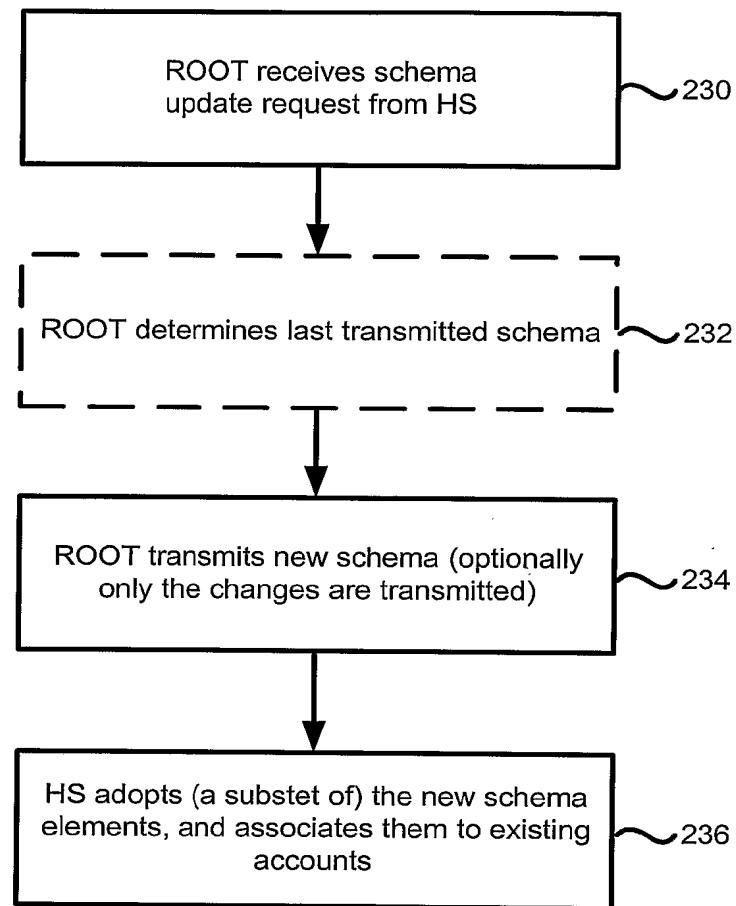


Figure 7

8/10

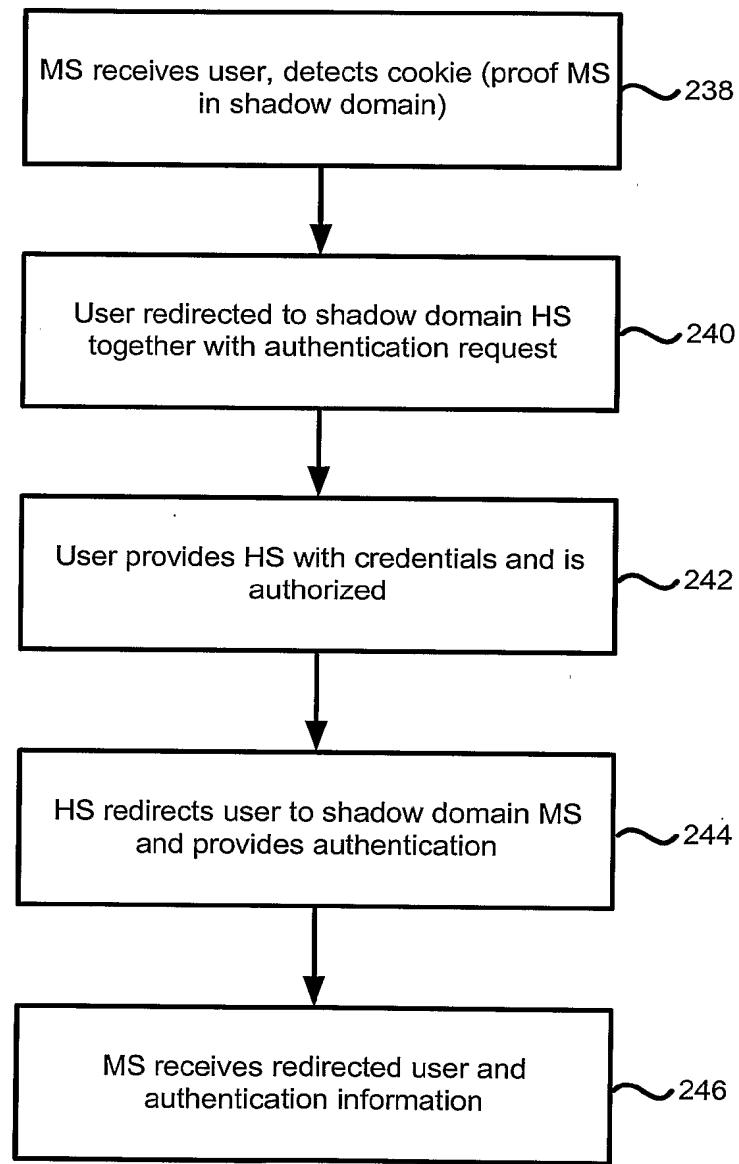


Figure 8

9/10

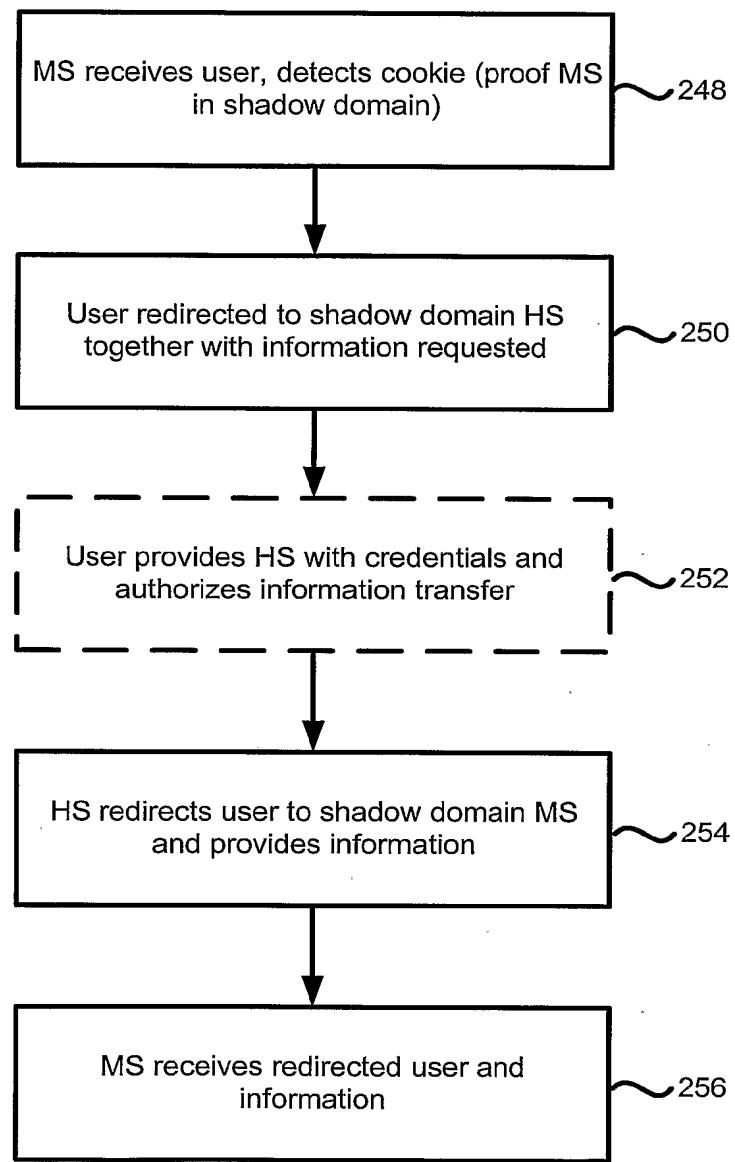


Figure 9

10/10

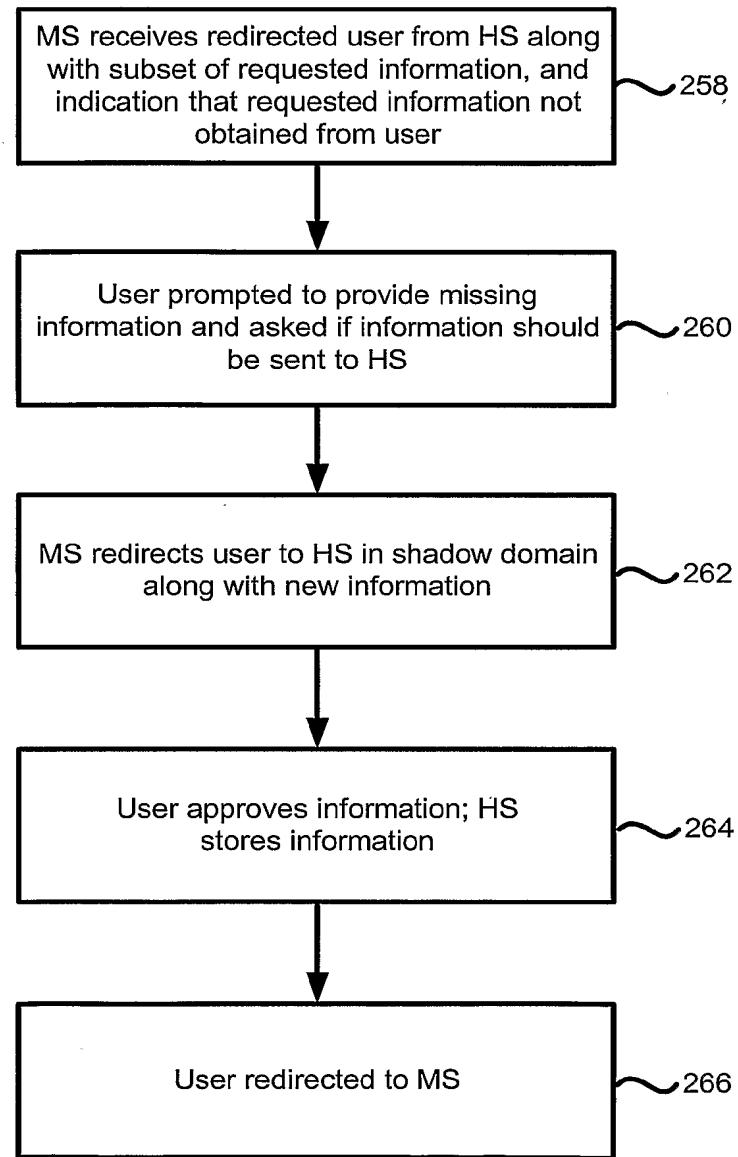


Figure 10